11 Is There a Surgical Treatment of Patellofemoral Pain?

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11.1 Background

It is widely accepted that the vast majority of patients with anterior knee pain (AKP) do not need a surgery; they only need conservative treatment [1–3]. In more cases than desirable, the AKP patient worsens after surgical treatment [4]. In fact, many surgeries in AKP patients are undertaken to address complications from previous poorly performed or badly indicated surgeries intended to treat AKP [4]. The patellofemoral joint (PFJ) does not really tolerate surgical procedures that do not respect its unique anatomical, biological, and biomechanical characteristics [5, 6]. That is why AKP surgery is not performed frequently. However, the results of conservative treatment for AKP are often frustrating—40% of AKP patients have an unfavorable recovery with conservative treatment at 12 months after the initial diagnosis [7]. This high percentage of unfavorable results may be due to some of these patients actually needing surgical treatment but not receiving it because their doctor lacks adequate knowledge to make a precise diagnosis.

Poor results of surgery in AKP patients may arise either because the diagnoses are inaccurate or because physiopathological premises (i.e., "pathologic" tibial tuberosity-trochlear groove [TT-TG] distance) on which surgery is based are incorrect and therefore treatment is also incorrect. Currently, the TT-TG distance is widely used as an indicator for medialization of the tibial tubercle in the AKP patient. However, Tensho and colleagues [8] have proved that knee rotation affects the TT-TG distance more than tubercle malposition does. For this reason, it should not be used for tibial tubercle transfer as an indicator. Unfortunately, many orthopedic surgeons operate on what computed tomography (CT) or magnetic resonance imaging (MRI) shows, that is, chondropathy, lateral patellar subluxation, patellar tilt, or increment of the TT-TG distance. Using this information as the basis for surgery is a critical error—and it is responsible for the poor reputation of AKP surgery. The patient with AKP is at high risk of receiving surgical treatment with little or no scientific basis simply because AKP is a musculoskeletal pathologic entity with a poorly understood etiopathogenesis [9].

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For AKP patients who could benefit from surgery, a knowledgeable surgeon and a correct diagnosis are crucial. Required factors include a careful history, close attention to what the patient reports, physical examination, and use of imaging. Unfortunately, many orthopedic surgeons base their surgical indications on an MRI or CT alone—it seems they are operating on an image instead of a person. Speaking with a patient and physical examination are fundamental, but neglected too often. This, in turn, triggers a failed patellofemoral surgery. One of the most powerful causes of AKP that both doctors and the literature forget to mention is the pain resulting from torsional alterations of the lower limb. However, tibiofemoral rotation has yet to be integrated into our thinking. If we carry out a search on PubMed, we see that there are few papers on torsional alterations of the lower limbs in patellofemoral disorders [10–30]. Furthermore, most of them are recent and published by the same group of researchers. In fact, most of the current literature discusses patellar alignment in association with AKP as a problem of the patella itself (increased tilt or increased shift of the patella). However, in many cases the problem is not in the patella but in the femur. Then, it is of a vital importance to assess the rotational profiles of the femur and tibia in an AKP patient. As far back as in 1995, Flandry and Hughston [31] showed that the most frequent cause of failure of an extensor mechanism realignment surgery was the existence of an underlying torsional alteration not diagnosed and therefore not treated. Stevens and colleagues [26] have demonstrated clinical improvement after osteotomies of femur and/or tibia in patients with a previous failed surgery (tibial tubercle osteotomy, LRR or arthroscopic debridement) to treat AKP in whom torsional abnormalities of the lower limb were unnoticed. These authors state that many orthopedic surgeons focus only on the knee when they see an AKP patient. Torsional abnormalities are often unrecognized.

This chapter focuses on the patient with AKP without patellofemoral chondropathy or osteoarthritis as the cause of pain. Consequently, techniques such as the anteromedialization of the tibial tubercle (Fulkerson's osteotomy) and the patellofemoral arthroplasty are not analyzed in-depth here. This chapter analyzes the current state of knowledge of surgical treatment of AKP patients, emphasizing the importance of the diagnosis and treatment of torsional alterations of the lower limb. Surgical techniques include minimally invasive procedures, such as peripatellar synovectomy or resection of synovial hypertrophy around the inferior pole of the patella, and major surgical techniques such as rotational osteotomies. Indeed, limb osteotomy should be seriously considered as a part of the armamentarium for treating AKP patients.

11.2 When Surgery Is Needed: General Principles

AKP remains a challenging condition for an orthopedic surgeon. Although surgery is not habitually needed, it is also true that in many cases AKP patients come to an orthopedic surgeon in search of a surgical solution. The surgeon must then determine what surgical procedure, if any, has the potential to improve the patient's condition and, most importantly, do no harm them.

As suggested by Post and Dye "Think of surgery as a tool used to create an environment in which homeostasis may be restored" [2].

A right diagnosis is paramount. To arrive at that diagnosis, answers are needed to the following questions: (1) is AKP secondary to patellar instability, or does it arise from bone rubbing or tension in the soft tissues?; (2) does the patient have a neutral mechanical axis, or is varus or valgus present?; (3) does he or she have abnormal torsion (i.e., considerable external rotation of the tibia or internal rotation of the femur)?; and (4) is the quadriceps too tight? A critical factor to consider when treating AKP patients is whether patellofemoral instability is present concurrently. Treatment of underlying patellar instability in these patients should be undertaken with caution, and the patients must know that surgical patellar stabilization may not relieve AKP. Moreover, a careful assessment of the limb alignment is an essential part of the physical evaluation of the AKP patient.

Many orthopedic surgeons base their surgical indication for patellofemoral surgery on a TT-TG distance greater than 20 mm. Use of this parameter as the deciding factor is a critical mistake because it can be a source of surgical failure and iatrogenia. We must not use imaging numbers to treat a patient. Physical examination is the key part of assessing AKP.

Historically, great importance has been given to the presence of a lateral patellar subluxation, which is attributed to excessive traction of the lateral retinaculum (LR) in the AKP patient. However, the LR does not pull the patella laterally—it prevents it from moving too far medially. Lateral patellar subluxation could be due to inadequate lateral trochlear inclination, genu valgum, or abnormal femoral anteversion. If lateral subluxation of the patella is present, the patellar tendon approaches the tibial tuberosity from a more lateral direction. Specifically, when the quadriceps contracts, more of its force through the patellar tendon is diverted into pulling the tuberosity laterally, causing the tibia to rotate more externally on the femur. Therefore, using a lateral retinaculum release (LRR) to correct a lateral patellar subluxation is inappropriate. We must treat the underlying cause, for example, an excessive femoral anteversion.

A key step in surgical decision-making is to identify whether AKP is related to patellofemoral overload. Pain related to it is generally localized and worsened or improved depending on the load applied to the PFJ. Patients with localized, load-related pain may be more amenable to successful surgical treatment, while diffuse, constant pain generally does not improve with surgery.

A true skeletal malalignment of the lower limb could be responsible for focal overload in the PFJ [6, 28–30, 32–34]. In these cases, imaging studies such as single-photon emission computed tomography (SPECT)-CT can document overloaded areas (Fig. 11.1). Rotational osteotomies may be used to unload bone and peripatellar soft tissues and create an adequate environment for return to homeostasis. Addressing the involved structures (trochlea, cartilage, and ligaments) does not address the cause of the abnormal force that produces focal overload; however, osteotomy is strongly able to change the direction of the force. This ability is particularly important when an abnormal limb alignment (transverse or coronal plane or combination) is present. If the cartilage is repaired, but the mechanics that caused its failure are ignored, failure is the likely outcome. It appears to be adequate to place the trochlear groove under the patella instead of forcing the

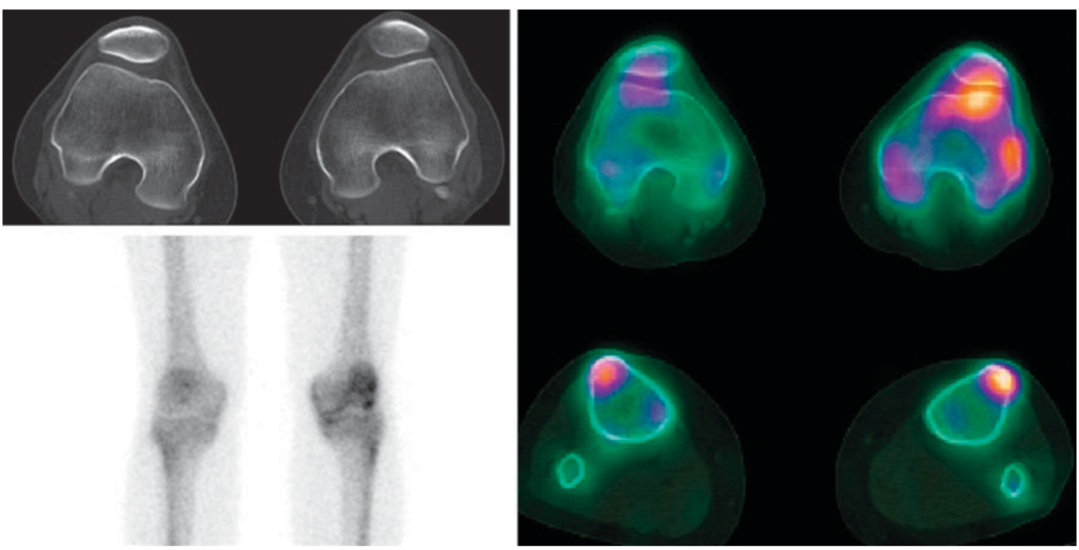

Fig. 11.1 SPECT-CT in an AKP patient with 40° of external tibial rotation. External tibial rotation increases pressure on the lateral side of the PFJ

latter over the trochlear groove. In short, think about limb alignment, not patellar alignment. Paulos and colleagues [25] compared 2 surgical techniques in 25 patients with patellar instability and significant lower leg deformities. Group 1 underwent a rotational high tibial osteotomy, and Group 2 underwent an Elmslie-Trillat-Fulkerson proximal-distal realignment. Results in Group 1 were significantly better than those in Group 2.

In short, we must always evaluate the following: (1) skeletal alignment (i.e., geometry, including the trochlea); (2) ligaments (i.e., the presence of hypermobility and its cause and location); (3) articular cartilage (i.e., complete or partial loss, location of the loss, possibility to shift contact to intact cartilage); and (4) muscle (i.e., symmetrical atrophy versus gross imbalance).

11.3 Minimally Invasive Surgical Procedures

LRR has a long history, and it has often been used to treat AKP recalcitrant to conservative treatment in very selected patients with a patellar tilt and a tight LR, which is demonstrated by an inability to evert the lateral patella to a neutral position on physical examination [35]. In a systematic review of literature, Lattermann and colleagues [36] demonstrated that the isolated LRR for AKP yielded 76% of good results with no significant difference between open or arthroscopic procedures. They showed a need for revision surgery in 12% of the cases after a 52-month follow-up, but they emphasized that the surgical procedure is necessary in less than 15% of AKP patients. Nevertheless, the authors drew attention to the need for randomized clinical trials to assess the advantages of this procedure when treating AKP. Currently, however, experienced knee surgeons with a special interest in the patellofemoral joint rarely perform isolated LRR [37]. Iatrogenic medial patellar instability has been described after excessive LRR or in the setting of LRR performed in cases of patellar tilt without a tight LR or in patients with a severe trochlear dysplasia [38]. Lateral retinacular lengthening has been reported as an alternative to LRR in order to avoid eventual complications of itself [37]. Moreover, releasing the painful retinaculum in a limited way in a very selected group of AKP patients may relieve pain [39]. Finally, arthroscopic LRR of a symptomatic type III bipartite patella without excision of the accessory bone fragment is related to excellent AKP relief and early return to sport activities [40].

When a focal soft tissue source of AKP refractory to an adequate conservative treatment can be identified, arthroscopic debridement of this pathologic tissue can relieve the pain [41, 42]. The most frequent sources of pain would be synovial hypertrophy around the inferior pole of the patella, Hoffa fat pad impingement, or peripatellar synovitis. Use of a superomedial portal could help to avoid potential errors arising from viewing the anterior compartment from a peripatellar tendon portal [2]. These minimally invasive surgical procedures should not be approached lightly. It is imperative to avoid postoperative hemarthrosis, which can be very painful and set back restoration of homeostasis [1, 2]. Therefore, intraoperative hemostasis must be meticulous, and a 24-hour drain through one of the arthroscopic portals of the patient's knee is advised. Other patients may require removal of a chronically tender synovial band of tissue or plica. Moreover, it has been suggested that the ligamentum mucosum (i.e., infrapatellar plica) could potentially play a role in the pathogenesis of AKP [43]. Release or resection of the infrapatellar plica, which tethers the Hoffa fat pad, significantly improves AKP in these patients [44]. In patients with AKP recalcitrant to conservative treatment for more than 6 months and with no associated structural anomalies, patellar denervation could be an option [45].

Soft tissue impingement can also be associated with osseous hypertension, which can produce transitory ischemia and mechanical stimulation of nociceptors and therefore pain. Patients with an intraosseous hypertension of the patella with a positive pain provocation test (i.e., pain reproduced by raising infrapatellar pressure) could be good candidates for extra-articular arthroscopic patellar decompression [46].

11.4 Major Surgical Procedures: Osteotomies

In the setting of patella alta, excessive load of the distal patella can occur due to decreased engagement of the patella in the trochlea, concentrating load on a smaller than normal area of cartilage with a resultant increase in cartilage load which may provoke cartilage wear [47]. These patients may respond positively to treatment with a distalizing tibial tubercle osteotomy that increases contact area with triggered decrease in PF pressure. In case of a lateralized tibial tubercle with a visible patellofemoral maltracking and a correct alignment of the limb, a tibial tubercle osteotomy can be considered. Anteromedialization of the tubercle can effectively unload the lateral and distal aspects of the patella in these situations and yield excellent pain relief [48–50]. This procedure is especially attractive in the face of concurrent lateral patellofemoral osteoarthritis.

In cases when all of the following are present: (1) diffuse disproportionate patellar cartilage softening, (2) disabling AKP, (3) failure of adequate physical therapy treatment, and (4) normal patellofemoral tracking, a fresh patellar allograft transplantation could be a good option [51].

11.4.1 Torsional Malalignment of the Lower Limb

A not infrequent cause of intractable AKP is the torsional malalignment of the lower limb [10, 11, 13–19, 21, 22, 24, 26]. It is very often missed, despite being easy to detect, but more common than generally appreciated.

11.4.1.1 Rationale

Limb alignment appears to have a very powerful influence on the quadriceps vector [30]. If an abnormal quadriceps vector is an important contributor to AKP and skeletal malalignment of the lower limb explains the offending quadriceps vector, then any torsion or coronal correction is important [30]. It is important to note that small alterations in skeletal alignment of the lower limb can result in significant alterations in PFJ stresses. Osteotomy has a strong ability to change the direction of the force and therefore treat these patients.

Lee and colleagues [33] have demonstrated that femoral rotation results in an increase in PFJ contact pressures on the contralateral facet of the patella (i.e., lateral PFJ during internal rotation of the femur and vice versa) and tibial rotation results in an increase in PFJ contact pressures on the ipsilateral facet of the patella. Lee and colleagues have demonstrated that tibial rotation has an influence not only on PFJ contact pressures and areas but also on strain in the peripatellar retinaculum [6]. More recently, Passmore and colleagues [34] have shown that idiopathic lower limb torsional deformities of the femur and tibia in children and adolescents are associated with gait impairments as well as a loading increment of the hip and PFJ. Thus, idiopathic lower limb torsional deformities are not a purely cosmetic issue. Using a finite element model, Liao and colleagues [52] have demonstrated that internal rotation of the femur provokes and increment of the PFJ stress.

11.4.1.2 Clinical Evaluation

Two types of torsional alteration of the lower limb are possible: (1) excessive external tibial torsion (Fig. 11.2) and (2) excessive femoral anteversion associated with an increased external tibial torsion (Fig. 11.3). One of the questions yet to be answered, biomechanically, is “Are excess tibial torsion and excess of femoral anteversion of equal mechanical importance?” or “Does tibial or femoral torsion have a greater negative mechanical influence?”. The importance

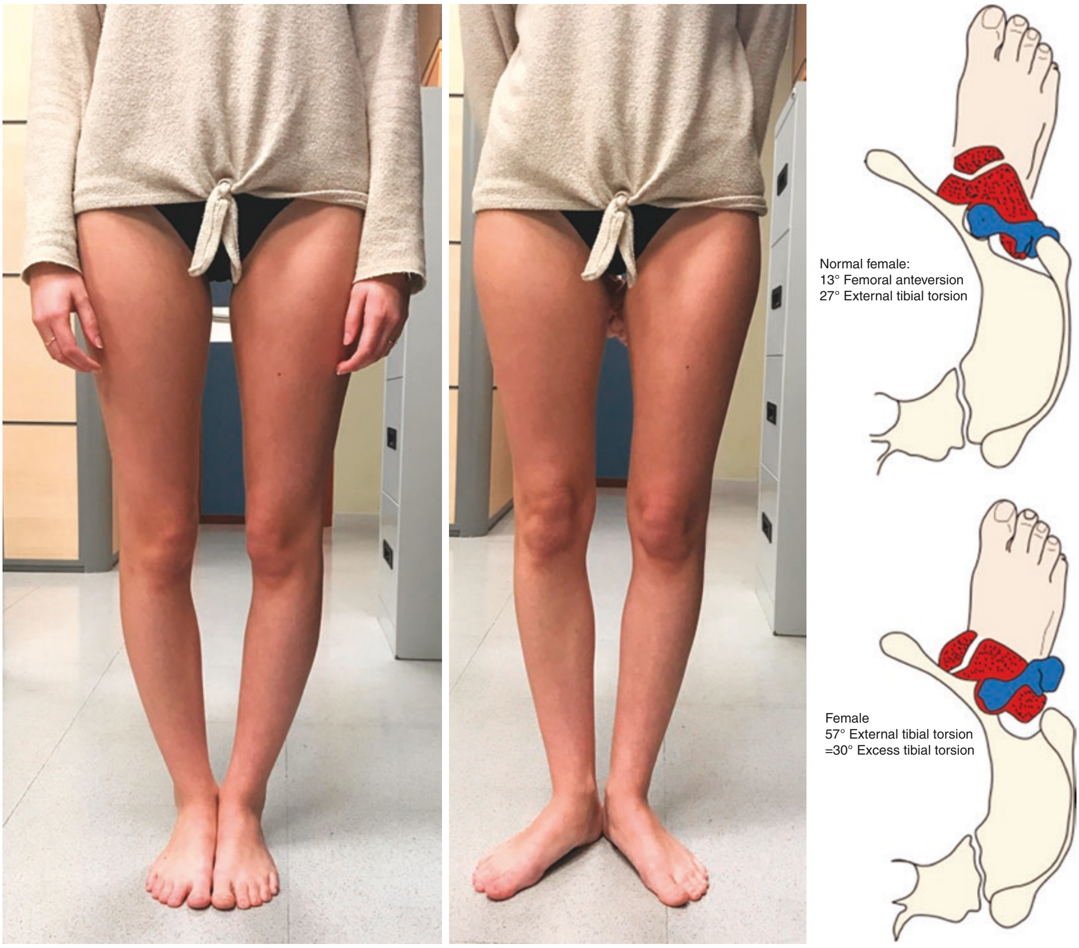

Fig. 11.2 Squinting patella in a patient with excessive external tibial torsion. (Photographs: Reused with permission from AME Publishing Company. From Sanchis-Alfonso V et al. Ann Joint 2018; 3:26. Graphics: Reused with permission from Elsevier. From Teitge RA. Patellofemoral Disorders Correction of Rotational Malalignment of the Lower Extremity. In: Noyess Knee Disorders: Surgery, Rehabilitation, Clinical Outcomes, 2017)

of different maltorsions is unclear. In theory, we should operate on the level with the greatest deformity, recognizing that it may be necessary to operate on the other level in a second surgery. When we must perform both femoral and tibial rotational osteotomy, we recommend performing the two procedures simultaneously. Osteotomy may be placed anywhere between the reference lines used to measure a torsional deformity.

Coronal deformities must not be overlooked because both torsional deformities and coronal plane deformities are associated in many cases. The most common multiplanar deformity in AKP patients is internal femoral torsion and valgus, and in these cases, both deformities must be corrected [30].

When the patient stands with their feet parallel, the patella should be facing forward. In patients with excessive external tibial torsion, we can see a squinting patella and a genu varum (Fig. 11.2). The combination of increased femoral anteversion and increased external tibial torsion has

Fig. 11.3 Miserable malalignment syndrome. (Graphics: Reused with permission from Elsevier. From Teitge RA. Patellofemoral Disorders Correction of Rotational Malalignment of the Lower Extremity. In: Noyess Knee Disorders: Surgery, Rehabilitation, Clinical Outcomes, 2017)

been termed miserable malalignment syndrome that includes squinting patella, genu varum, genu recurvatum, and pronated foot (Fig. 11.3).

In prone position we must measure the proportion of internal to external rotations of the hips in extension [53]. If internal rotation exceeds external rotation in more than 30 degrees, there is an increased femoral anteversion (Fig. 11.4). In cases with isolated excessive external tibial torsion, internal and external rotations are similar (Fig. 11.5).

What is more, it is important to evaluate the foot progression angle. The "foot progression angle" should be neutral when walking [54, 55]. An excessive femoral anteversion is manifested by a gait pattern with an internal foot progression angle (in-toeing) and external tibial torsion by out-toeing (Fig. 11.6) [26]. However, if an excessive femoral anteversion is associated to excessive external tibial torsion (i.e., pan genu torsion or miserable malalignment), the foot progression angle will be neutral, and this combined long bone deformity may be concealed to the unwary observer [11, 26]. It is therefore important to have a patient appropriately unclad and note that the knee progression angle is inward [11, 26].

11.4.1.3 Measuring Torsion

Measuring torsion may be accomplished with either CT or MRI, although controversy exists about which method is the most accurate and reproducible [56, 57]. However, CT and MRI are not interchangeable when they are used to evaluate femoral anteversion [58]. Moreover, CT has higher interobserver reliability than MRI [58]. Excessive femoral anteversion has different thresholds according to MRI and CT measurements [58]. According to Parikh and Noyes, MRI has an advantage over CT because femoral anteversion measurements are more accurate and ionizing radiation is avoided [57]. In addition, measured values vary greatly in the literature. CT

Fig. 11.4 Evaluation in prone position in a patient with excessive right femoral anteversion

is crucial to accurately analyze rotational lower limb alignment (Figs. 11.7 and 11.8). Kaiser and colleagues [56] showed that femoral torsion measurements can differ by more than 10 degrees, depending on the measurement technique used.

In our clinical practice, we use the technique described by Murphy and colleagues [59] in 1987 because we find that it is the most anatomic, accurate, and reproducible—high intra- (ICC: 0.95–0.98) and interobserver agreement (ICC: 0.93) has been reported for this method [56]. Murphy and colleagues reported that the common method of running a line along the femoral neck on a CT image underestimated the actual anteversion by a mean of 13° [59]. The line that is used as the axis of the femoral neck is not the true axis of the femoral neck (Fig. 11.7). Our reference normal values are femoral anteversion 13° and external tibial torsion 21° in males and 27° in females [28, 29, 60].

11.4.1.4 Surgical Tips in Rotational Osteotomies

Rotational osteotomies are often performed according to the experience of the surgeon. There is no evidence to support decisions regarding sur-

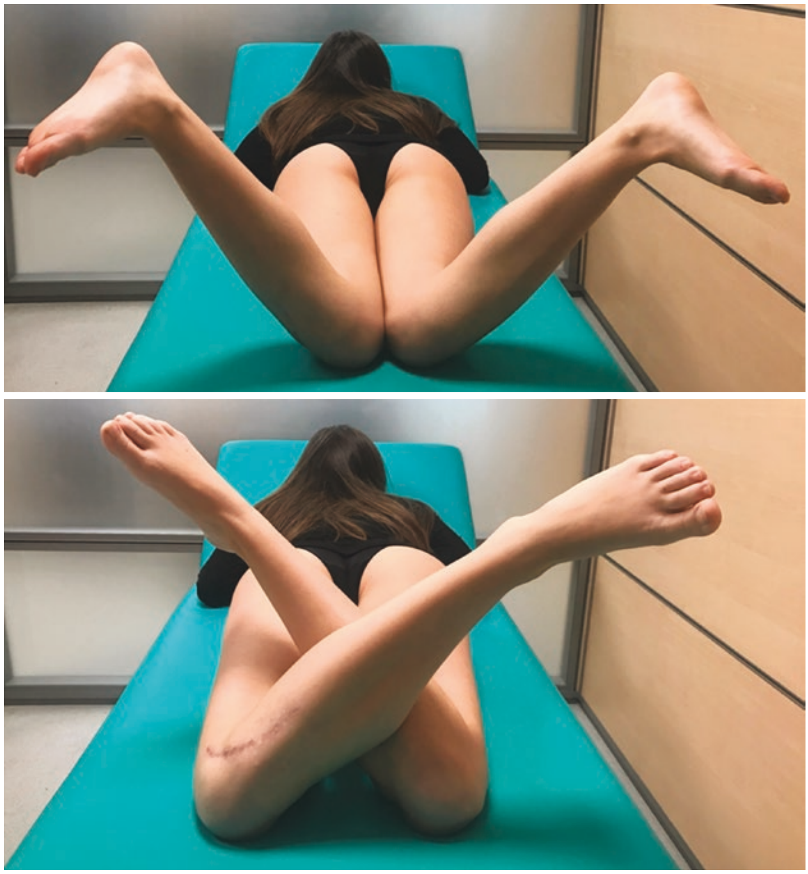

Fig. 11.5 Evaluation in prone position in a patient with near normal hip motion (femoral anteversion). This patient had an excessive external tibial torsion measured with CT

gical technique or level of osteotomy. We do not know if maltorsion exists at a particular location since we are only measuring torsion as the angle between the proximal and distal joint axis. The objective is to create the proper angular relationship in the transverse plane between the two axes. We can accomplish this at any location between the two axes in question.

In preparation for a rotational osteotomy, the patient is placed in supine position on a radiolucent table. The entire limb is exposed. The foot is in a sterile transparent bag and the drape rests above the hip joint so the entire limb is visible after correction. A tourniquet is not used, and the C-arm is placed on the opposite side to the operated limb. Femoral rotational osteotomy can also be performed using a fracture table.

Undercorrecting is better than overcorrecting. The objective is a correction that is slightly less than what a torsion measurement might indicate. For example, if a patient has a femoral anteversion of 49°, the aim should be an external femoral rotation of 30° but not more (49 − 30 = 19). For an external tibial torsion of 56°, we would propose an internal rotational osteotomy of 30° (56 − 30 = 26). But we do not know what the minimum correction is necessary for the surgery to be successful (Fig. 11.9). According to Lerat and Raguet [21], the risk of neurovascular complications increases significantly above 30° of correction in the tibia.

Rotational osteotomy of the femur may be made anywhere between the hip joint and the knee joint. There is no evidence that proximal,

Fig. 11.6 Foot progression angle in a patient with excessive external tibial torsion. In this case the foot is externally rotated during the swing phase of gait, then internal rotation osteotomy of the tibia should result in a neutral foot progression angle during stance phase; and this is something considered as correct. If the foot is neutral during the swing phase of gait, then internal rotation of the tibia can result in an in-toeing gait during stance phase. And this, on the other hand, is not correct. (Reused with permission from AME Publishing Company. From Sanchis-Alfonso et al. Ann Joint 2018; 3:26)

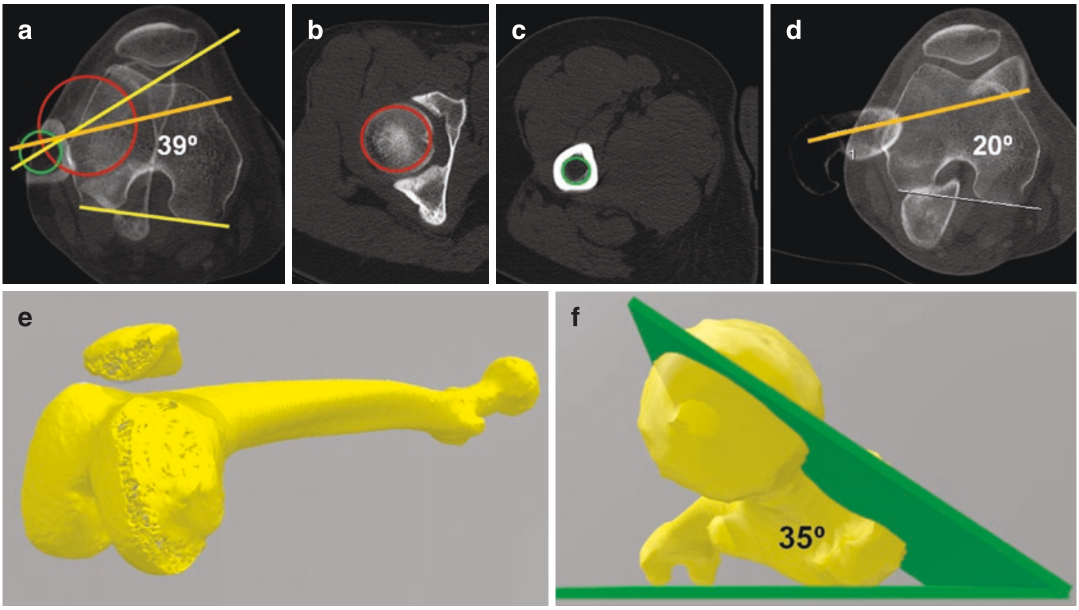

Fig. 11.7 Measurement of femoral anteversion. (**a**) Technique described by Murphy and colleagues. Draw a circle on the femoral head (**b**) and another circle centered in the femoral shaft below to the lesser trochanter (**c**). Then draw a line connecting the center of these two circles. This line defines the femoral neck axis in the transverse plane. Then draw a line tangent to the posterior aspect of the femoral condyles (posterior condylar line). The angle between these two lines represents the femoral anteversion. (**d**) Method commonly used to measure femoral anteversion. The line that is used as the axis of the femoral neck (orange line) is not the true axis of the femoral neck. (**e**) Whole femur 3D reconstruction. (**f**) Femoral anteversion of the same patient measured on 3D reconstruction of the whole femur

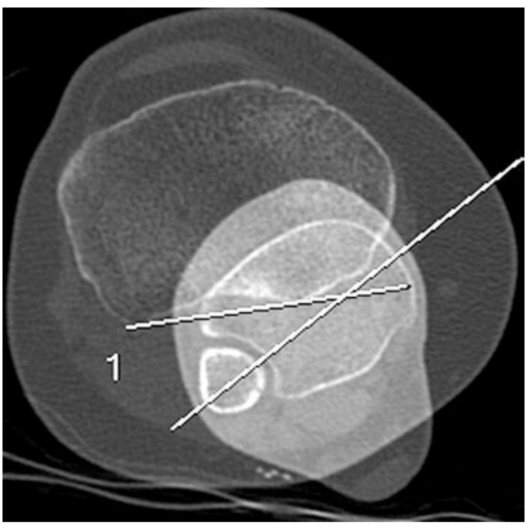

Fig. 11.8 Measurement of external tibial torsion. It is measured as the angle between the posterior aspect of the tibial metaphysis and the ankle joint line

mid-shaft, or distal location of the osteotomy is preferable. We have most often performed femoral rotational osteotomy at the intertrochanteric level to avoid any scarring to the quadriceps muscle in the region of the knee. It is more straightforward to control the varus-valgus and flexion-extension at this particular level as the femur is more cylindrical. However, in case of the deformity of knee varus or valgus, the correction must be made closer to the knee joint, and usually it would be in the supracondylar region. After marking the osteotomy level with a K-wire, we insert two K-wires at an angle equal to the desired rotational correction, one proximal and one distal to the osteotomy site. The osteotomy is completed using an oscillating saw while protecting soft tissues with two Hohmann retractors. After the osteotomy is complete, external rotation of the

Fig. 11.9 Bilateral severe external tibial torsion (CT measurement: 72°). Patient operated on both legs by tibial osteotomy of internal rotation with an excellent result in both limbs despite the undercorrection of the left side

distal fragment is performed until both K-wires are parallel, which indicates that the planned correction has been achieved (Figs. 11.10 and 11.11). We then perform the osteosynthesis. In cases of proximal osteotomy, we can use a 95° angled blade plate (DePuy Synthes) as the insertion of a blade into the proximal fragment gives an excellent proximal fixation, the distal shaft fragment is easily aligned to the plate, and a lateral plate under tension counters the normal varus bending stress in the proximal femur. When the 95° angled blade plate is selected, the track for blade is created in the center of the femoral neck before the osteotomy is performed. The blade of the blade plate is inserted into the femoral neck after the osteotomy is complete. This provides accurate control of the location of the proximal fragment. Another option would be a proximal femoral locking compression plate (LCP) 4.5/5.0 (DePuy Synthes) [23].

As with the femoral osteotomy, tibial rotational osteotomy has also been performed at any level. Our preference is below tibial tuberosity. Kuroda and colleagues have demonstrated that medial tuberosity transfer from the nor-

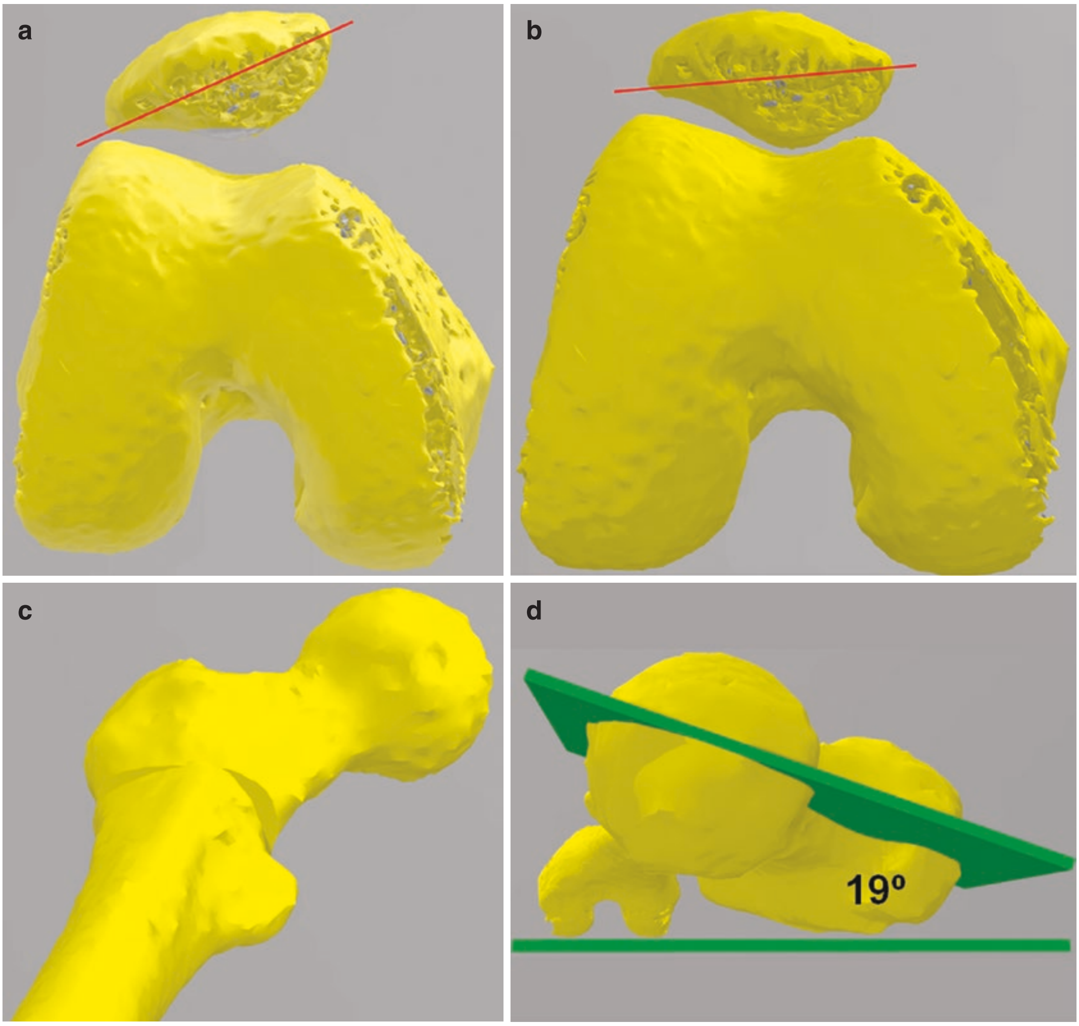

Fig. 11.10 Think about limb alignment, not patellar alignment. (**a**) Preoperative position of the patella with respect to the femur with the knee in extension. (**b**, **c**) Position of the patella with respect to the femur with the knee in extension after proximal femoral osteotomy. The distal fragment has been rotated externally 20°. You can observe a correct patellofemoral congruence. (**d**) The femoral anteversion of the femur measured on a 3D reconstruction is 19°. In the contralateral asymptomatic hip, the femoral anteversion is 15°

mal position will provoke an increment of the medial tibiofemoral compartment pressure and medial patellofemoral pressure and a decrease of the lateral tibiofemoral pressure that theoretically leads to medial compartment osteoarthritis, degenerative tears of the medial meniscus, and medial patellofemoral osteoarthritis [61]. If we place the osteotomy above the tubercle, we will move it medially which will create joint imbalance. We always perform a peroneal nerve release. Moreover, fibular osteotomy is recommended before making the tibial rotation because (1) the fibula provides some degree of resistance to prevent rotation of the tibia and (2) the fibula must pull on the proximal and distal tibiofibular capsule, which could be painful. A proximal long oblique cut is recommended because it provides a larger surface area of contact between the bones, making healing easier. With a transverse osteotomy, enough rotation is present to prevent

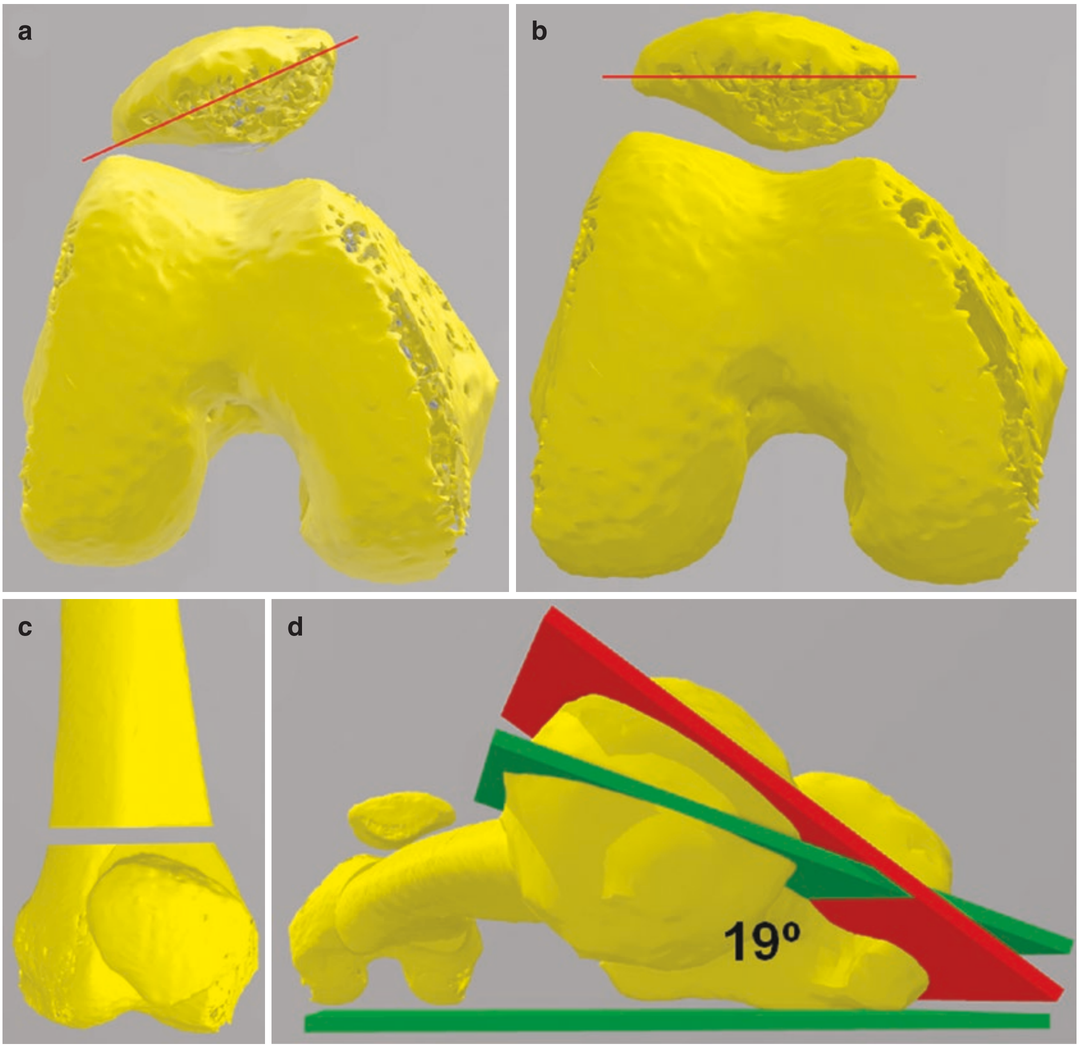

Fig. 11.11 Think about limb alignment, not patellar alignment. (**a**) Preoperative position of the patella with respect to the femur with the knee in extension. (**b**, **c**) Position of the patella with respect to the femur with the knee in extension after distal femoral osteotomy. The distal fragment has been rotated externally 20°. You can observe a correct patellofemoral congruence. (**d**) The femoral anteversion of the femur measured on a 3D reconstruction is 19°. In the contralateral asymptomatic hip, the femoral anteversion is 15°. In red, the preoperative femoral anteversion

two fragments from being in contact, and healing can take more than 1 year. To protect the nerve while making the osteotomy with a small saw, we place two hallux retractors around the neck of the fibula.

Prior to tibial osteotomy, we mark the osteotomy level with a K-wire. We then place two K-wires at the desired correction angle, perform the osteotomy below the tibial tuberosity, derotate the tibia, and check.

The varus in patients with external tibial rotation may be real, or it may be a reflection of the tibial torsion (thus pseudo-varus) (Fig. 11.12). In Fig. 11.13 we can observe a varus correction after isolated internal tibial rotation osteotomy. Therefore, it is very important to check whether there is a neutral coronal plane alignment after rotation, before fixation. We use the alignment rod from the center of the femoral head to the center of the talus to make sure the mechanical

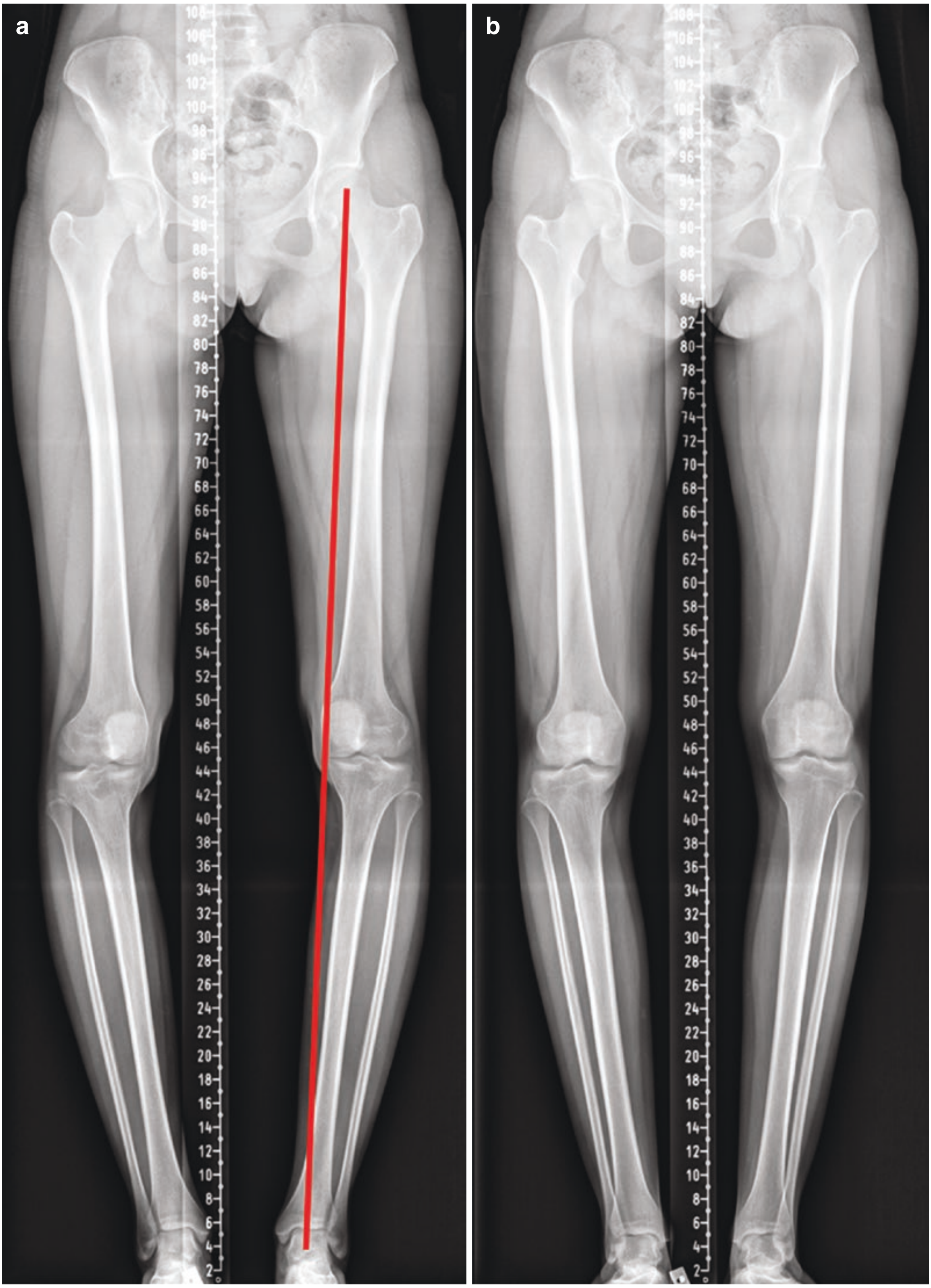

Fig. 11.12 An example of skeletal malalignment of the lower limb: excessive external tibial torsion associated to excessive femoral anteversion. Anteroposterior weight-bearing radiography of the lower limbs with the feet straight forward (**a**) and with the feet externally rotated (**b**). Mechanical axis—varus deformity (red line). In the coronal plane, the patella should be centered in the middle of the distal femur unless the patella is known to be subluxed laterally. Observe how with the feet straightforward the patella is inward and with the knee joint pointing forward the feet points laterally

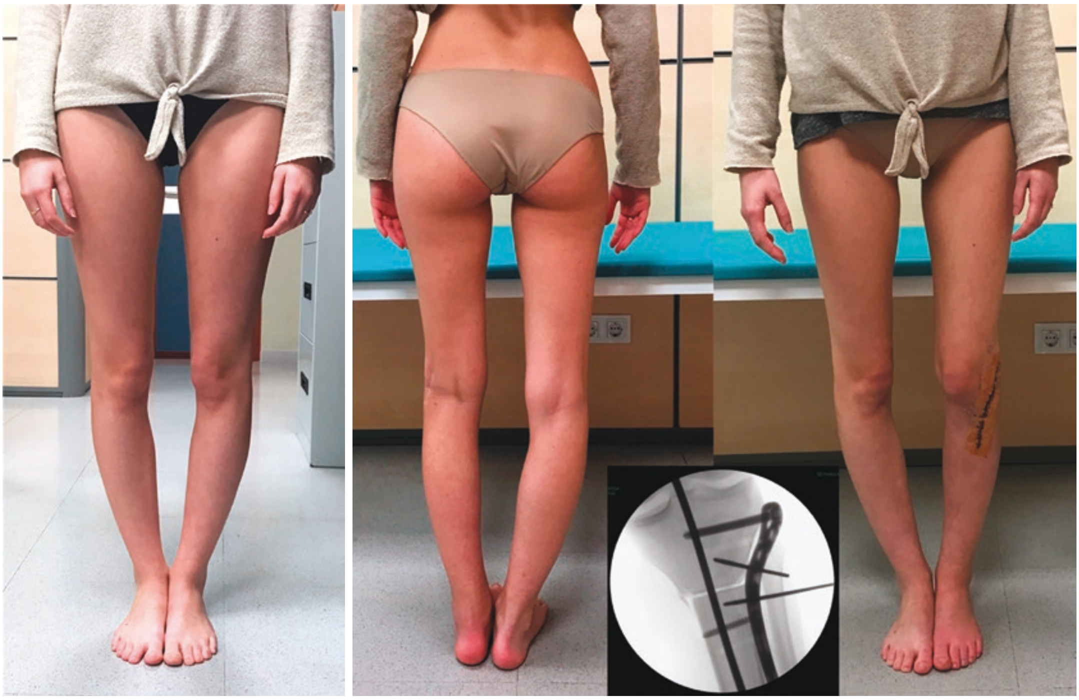

Fig. 11.13 In most of the cases, the varus is not real, but it is a reflection of the tibial torsion (thus pseudo-varus). A varus correction after isolated internal tibial rotational osteotomy can be observed on the left limb. (Reused with permission from AME Publishing Company. From Sanchis-Alfonso et al. Ann Joint 2018; 3:26)

axis falls near the medial tibial spine. A normal mechanical axis is actually near the medial tibial spine, not in the center of the knee joint. The patella must always be pointing straightforward, and it should also be in the middle of the distal femur on the anteroposterior image. We use a lateral TomoFix plate (DePuy Synthes) for osteotomy fixation.

We always use a drain to reduce risk of hematoma and compartment syndrome. If the anterior compartment is very tight, we leave the fascia open.

We encourage active hip, knee, and ankle motion immediately after surgery. The patient uses crutches to prevent bearing weight with the operated leg. Loading is permitted after 6 weeks.

11.5 Conclusion

The gold standard in the treatment of AKP is physical therapy within the patient's envelope of function. Surgery for AKP is a last resort, and very often it is not needed. However, certain surgical procedures in a carefully selected patient can significantly improve AKP resistant to all non-operative alternatives. Surgical treatment must be considered only when well-documented anomalies amenable to a specific targeted intervention are present, especially when there is evidence of focal patellofemoral overload. Every surgical treatment ought to be tailor-made just because every person is different. For example, when focal pathology, such as synovial hypertrophy around the inferior pole of the patella or peripatellar synovitis, can be identified, procedures to debride inflammatory foci in the synovium can be very successful. Finally, in some cases, major surgery, such as osteotomy, to correct abnormal femoral and tibial torsion may be essential for the optimal treatment of AKP. In our experience, AKP patients with an underlying torsional abnormality respond very well to derotational corrective osteotomies.

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